

JRBM vol 5 Issue 1 (2005?)

Influence of soil-moisture and land use change on precipitation in the Volta Basin of West Africa

By HARALD KUNSTMANN and GERLINDE JUNG

An ongoing intensification of agriculture in West Africa has led to changes in surface and subsurface characteristics that may directly affect evaporation rates and, in turn, regional rainfall patterns. To investigate the effects of those changes, the Penn State University/National Center for Atmospheric Research (NCAR) mesoscale meteorological model (MM5) was applied for the identification of feedback mechanisms between land surface (soil and vegetation) and atmosphere. MM5 was applied in three different resolutions (81 x 81, 27 x 27, and 9 x 9 km²) with 2-way interactive grids. The objective of this work was to learn to what extent regional (intra-domain) evaporation determines rainfall within the domains. The effect of decreased and increased initial soil moisture on total rainfall and on precipitation recycling indicators was investigated. Scale dependent, positive (increased precipitation at increased initial soil moisture) as well as negative (decreased precipitation at increased initial soil moisture) feedback mechanisms were found. Detailed atmospheric water budget analysis showed that negative feedback mechanisms on the small domain appeared to have been caused by an increased inflow of atmospheric moisture. Sensitivity of precipitation with respect to soil moisture was very variable over space. Both negative and positive sensitivities were observed. To investigate the effect of land use change, the total rainfall distribution was computed under the assumption of the observed land use substitution from cropland woodland mosaic into shrub land and finally into grassland. Sensitivity of precipitation with respect to land use change was very heterogeneous. Total precipitation change was of the same order of magnitude as in case of the initial soil moisture perturbations.